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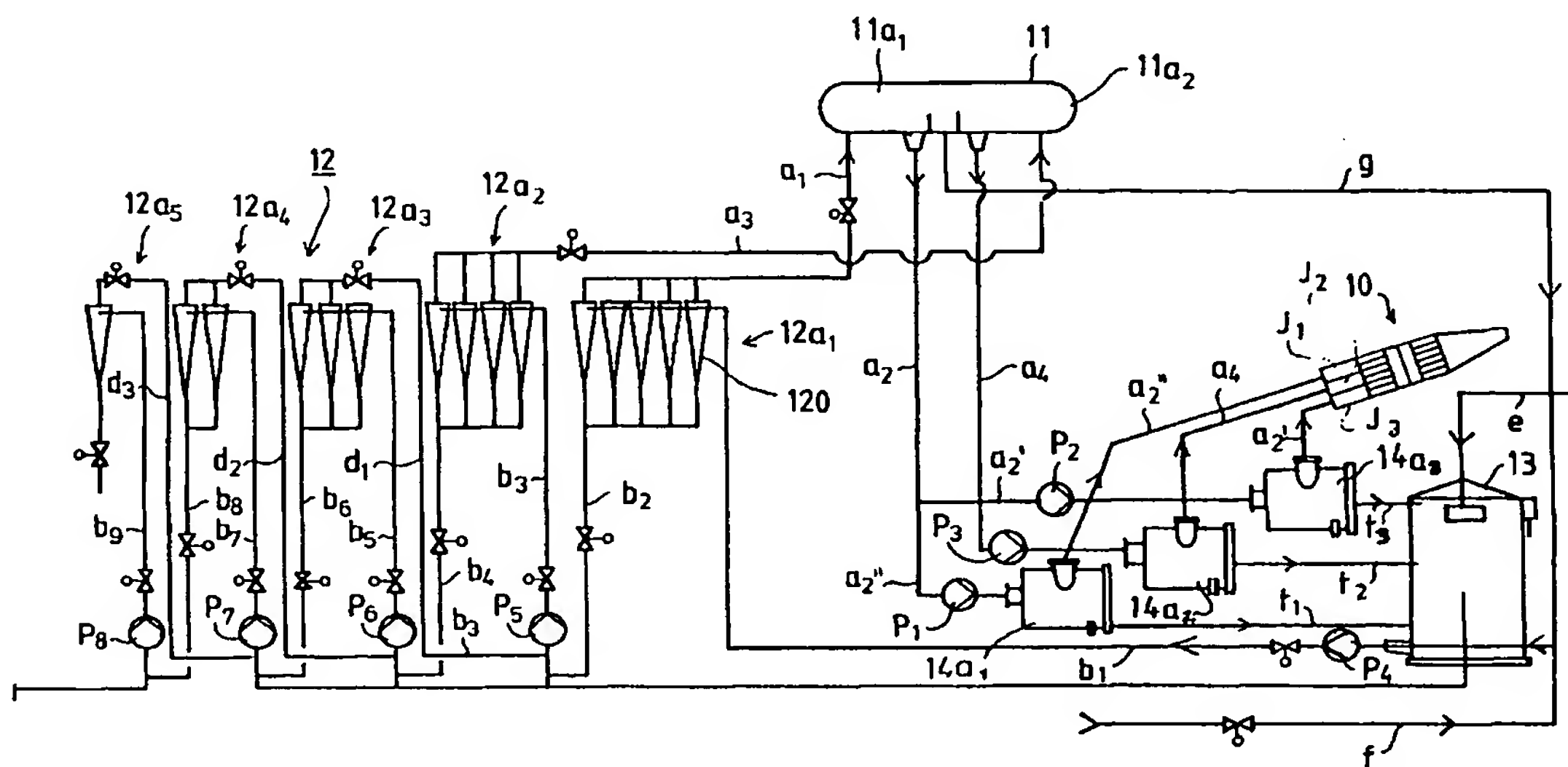
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(54) Title: METHOD AND EQUIPMENT FOR PULP FRACTIONATION IN A PAPER OR BOARD MACHINE



(57) Abstract: The invention concerns a method and equipment for pulp fractionation in a paper or board machine. In the method, virgin stock is conducted to the paper or board machine and further to a centrifugal cleaner installation (12) into its first centrifugal cleaner step (12a₁). From the first centrifugal cleaner step (12a₁) the accept is conducted into a multi-layer headbox (10) to form a layer of the web determined according to the concerned fraction. From a second step (12a₂) and/or from lower steps (12a₃, 12a₄... 12a_n) of the centrifugal cleaner installation (12) a second fraction or more fractions are conducted into the multi-layer headbox (10) to form a second layer or other layers of the web, which are determined according to the pulp fractionation taking place in the concerned second step or lower steps.

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Method and equipment for pulp fractionation in a paper or board machine

- 5 The invention concerns a method and equipment for pulp fractionation in a paper machine or such, such as a board machine

Multi-layer headboxes are already in use with many board grades and they are also on their way to printing paper machines. Layering has traditionally been done by
10 layering the supply of either filler or retention agents. It is a weakness of this system that the pulp itself is entirely similar in all layers, so the drainability, fibre content and quantities of fines in the layers are not different. This of course limits the efficiency of layering.

15 Alternatively with e.g. tissue or board machines the different raw material components, such as short and long fibre, are treated separately from each other all the way from pulp treatment to the headbox. In such a system a double pulp system must of course be built all the way from pulp treatment to the paper machine.

20 Fractionation plants are used also in the production of pulp. Pressurized screens are generally used in the fractionation, and the fractionation is performed already at the pulp plant. In this case too a double pulp system must be built for the paper machine.

25 In the system according to the invention, the pulp is brought mixed into the short circulation of the paper machine. For example, in a machine using 100 % recycled fibre, there is only one raw material, whereby pulp layering without fractionation cannot be done at all.

30 The centrifugal cleaners traditionally used in the short circulation of the paper

machine have been used only to separate sand. The centrifugal cleaner installation separates pulp e.g. according to its density, size, shape and surface roughness. In the system according to the invention, the fractionation done by centrifugal cleaners is utilised in such a way that the accept of a certain centrifugal cleaner is conducted into a certain bypass manifold of the multi-layer headbox to form a certain web layer. In the system according to the invention, the fractionation ability of centrifugal cleaners is utilised e.g. in such a way that the fraction having more fines or long fibres is guided into the bottom and/or surface layer of the headbox.

In the first step of centrifugal cleaning, the pulp is divided roughly in a suitable proportion between the various layers. The final fine control of proportioning takes place only at the pump of the headbox. Surplus of pulp is circulated back to the input of the centrifugal cleaner.

Compared with filler layering, the quality of the pulp itself in the various layers can also be varied, and desired fibre fractions can be guided either to the surface or into the middle layer as required.

There is no need for any separate pulp systems before the centrifugal cleaners, but all pulp is brought in only one line all the way to the short circulation.

The equipment already in the short circulation is utilised and there is no need for any new partial processes. Only the operation of step 1 of the centrifugal cleaning is changed in such a way that the so-called reject ratio will correspond with the quantity of fibres needed in the various layers.

According to the invention, the pulp is conducted from the wire pit to the centrifugal cleaner, and from the first stage, that is, from step 1, of the centrifugal cleaner installation the pulp is conducted forward, in one embodiment of the invention into a deaeration tank, the reject of step 1 is conducted further into the

second stage of the centrifugal cleaner installation and thence the accept is conducted forward into the second part of the deaeration tank.

5 An advantageous embodiment of the invention is as follows. The accept arrived from the first stage of centrifugal cleaning into the deaeration tank is conducted from the deaeration tank into the part of the headbox forming the bottom and surface layers of the web, preferably through power screens. The pulp conducted as accept from the second stage, that is, from step 2, of the centrifugal cleaner into the deaeration tank is conducted through a power screen located in between the
10 deaeration tank and the headbox into the bypass manifold of the headbox, through which bypass manifold the pulp is conducted on to the formation wire to form the middle layer of the web.

Thus, in fractionation according to the invention, the centrifugal cleaner installation is utilised and the fractionation is carried out from various stages of the
15 centrifugal cleaner installation in such a way that the pulp conducted from the first stage into the deaeration tank is conducted further after deaeration to form top layers of the web, and the pulp conducted as accept from the second stage or from other stages is moved further from the concerned stage/stages of the centrifugal
20 cleaner installation to form other layers of the web, such as the middle layer of a three-layer web. However, it is not a purpose to limit the invention to the manner of forming a three-layer web described above. With the equipment according to the invention it is also possible to form two-layer paper or paper or board grades having even more layers instead of three-layer paper.

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The system thus utilises a centrifugal cleaner installation and its fractionation in the making of multi-layer paper. The system may be applied to such short circulations already in use, which include a centrifugal cleaner. One stock is conducted into short circulation and it is treated in such a way in the centrifugal
30 cleaner installation that the desired fraction can be conducted further through a deaeration tank to the multi-layer headbox into the pulp bypass manifold

corresponding with each layer. In the system according to the invention, a power screen may also be used in between the deaeration tank and the headbox in order to achieve the final fractionation result. Such an embodiment is also possible within the scope of the invention, where there is no deaeration from the pulp. In a system where there is no deaeration from the pulp, the accepts of centrifugal cleaning may be taken directly to the suction side of the headbox's feed pump. In other respects the structure of the system is similar to the one in the embodiment shown in Figure 1.

Such an embodiment may also be possible within the scope of the invention, wherein water leaving the wire section is conducted into the wire pit, from which wire pit the tail water is pumped into the deaeration tank and harmful air is removed from the tail water in the deaeration tank. Then the tail water is admixed with high-consistency pulp, which is conducted further into the centrifugal cleaner installation and further according to the invention from the centrifugal cleaner installation to the multi-layer headbox.

In an embodiment containing a deaeration tank this is preferably in two parts. From the deaeration tank there are discharge fittings for each desired fraction. The pulp fraction can then be branched off to form several layers or conducted without branching in order to form one layer containing the concerned fraction.

The method and equipment for pulp fractionation according to the invention are characterised by the features defined in the claims.

In the following, the invention will be described with reference to the embodiments in the appended figures, but the intention is not to limit the invention to these only.

Figure 1 is a schematic view of the fractionation system according to the invention.

Figure 2A is a schematic side view of the centrifugal cleaner of the first step of the centrifugal cleaner installation.

5 Figure 2B is a sectional view along line I - I in Figure 2A.

Figure 3 shows a second advantageous embodiment of the invention, wherein tail water is conducted into a deaeration tank and then virgin stock is admixed with the flow conducted from the deaeration tank, and the flow is conducted further
10 into the centrifugal cleaner installation and through this according to the invention to the multi-layer headbox.

Figure 1 shows schematically the equipment according to the invention for pulp fractionation. The equipment includes a multi-layer headbox 10 and a deaeration
15 tank 11, which is preferably in many sections, being a two-section tank in this embodiment of the invention. In addition, the system according to the invention includes a centrifugal cleaner installation 12, which includes at least two steps, steps 12a₁ and 12a₂, that is, centrifugal cleaning degrees. In addition, the system according to the invention includes a wire pit 13 and a fitting b₁ leading from this
20 to the first centrifugal cleaning step 12a₁ of the centrifugal cleaning installation 12. From the first step 12a₁ of the centrifugal cleaning installation 12 there is a further fitting a₁ for the accept into the deaeration tank 11, into the first section 11a₁ of the said tank. From tank 11a₁ there is another fitting a₂, which branches off to form fittings a₂' and a₂''. The fittings a₂' and a₂'' include power screens
25 14a₁ and 14a₂, from which the accept is conducted further along fittings a₂' and a₂'' to a multi-layer headbox 10 and into its bypass manifolds J₁ and J₃, from which the pulp is divided further into the headbox's set of pipes, through an intermediate chamber and a turbulence generator to the formation wire H₁ and to form the top and bottom layers of the web. The fittings, such as channels or pipes
30 a₂' and a₂'', include pumps P₂ and P₁ and , correspondingly, a pump P₃ is located in a fitting a₄. Using the pumps, the pulp fractions are pumped into each bypass

manifold J_1 , J_2 , J_3 of the multi-layer headbox 10.

From the first step $12a_1$ of the centrifugal cleaner installation 12 there is a fitting b_2 for the reject, and further to fitting b_3 , which leads to the second stage of centrifugal cleaner installation 12, that is, to second step $12a_2$, from which there is further a fitting a_3 for the accept into the second section $11a_2$ of the deaeration tank 11, and further a fitting a_4 , e.g. a pipe, into bypass manifold J_2 of the multi-layer headbox 10 to form the middle layer of the web. In this application, virgin stock is understood as being the new stock conducted to wire pit 13. The stock includes fillers and additives and fibres. Thus, from the first step $12a_1$ of the centrifugal cleaner installation 12 there is a fitting a_1 into multi-section deaeration tank 11, into its first section $11a_1$, from which after the deaeration the fraction is transferred further into fitting a_2 , which branches off to form branch fittings a_2' , a_2'' , which lead further into corresponding pulp bypass manifolds J_1 and J_3 of the multi-layer headbox 10. Branch fittings a_2' , a_2'' include power screens $14a_3$ and $14a_1$, from which the accept is conducted further to the corresponding bypass manifolds J_1 , J_3 of the headbox, and the reject is conducted along channels t_1 , t_3 back to the wire pit 13. Correspondingly, from the second step $12a_2$ of the centrifugal cleaner installation 12 the accept is conducted into multi-section deaeration tank 11, into its section $11a_2$ along fitting a_3 , and after the deaeration the said fraction is conducted to fitting a_4 , which is conducted further into the middle bypass manifold J_2 of the multi-layer headbox 10 to form the middle layer of the web. Fitting a_4 includes a power screen $14a_2$, from which the accept is conducted into bypass manifold J_2 of the multi-layer headbox 10, and the reject is conducted along fitting t_2 as a back flow back to wire pit 13.

As is shown in Figure 1, centrifugal cleaner installation 12 may include several steps. In the embodiment shown in Figure 1, there are two actual fractionation steps, which are steps $12a_1$ and $12a_2$, which are used for forming a three-layer web. Step $12a_1$ includes centrifugal cleaner cones 120, of which there are five in the step and the accept outlets of which are joined together, while, correspond-

ingly, the reject outlets are joined together. There is a corresponding arrangement in the other steps. The number of cones 120 in step 12a₂ is four, in step 12a₃ there are three, in step 12a₄ two and in the last step 12a₅ there is one cone 120. The reject outlet fitting b₂ of step 12a₁ is connected to supply channel b₃ of the second
5 step 12a₂. The reject outlet b₄ of step 12a₂ is connected to supply fitting b₅ of the third step 12a₃ and reject outlet b₆ of step 12a₃ is connected to supply fitting b₇ of step 12a₄, reject outlet fitting b₈ of step 12a₄ is connected to supply fitting b₉ of the last step 12a₅. The accepts of steps 12a₃, 12a₄ and 12a₅, for which there is a fitting d₁, d₂, d₃, are connected in such a way to the system that the accept of step
10 12a₃ is made to flow along fitting d₁ to the second step 12a₂, into its fitting b₃ to the suction side of feed pump P₅. Correspondingly, accept fitting d₂ of step 12a₄ is connected with supply channel b₅ of step 12a₃ on the suction side of feed pump PP₆ and, correspondingly, accept fitting d₃ of step 12a₅ is connected with supply fitting b₇ of step 12a₄ on the suction side of pump P₇. The reject taken from the
15 last step 12a₅ is moved entirely to the discharge or to further treatment in connection with another installation.

Fitting b₁ from wire pit 13 includes a feed pump P₄, and there is an input fitting f for virgin stock to the wire pit. For the tail water of the wire section there is a
20 return fitting e to wire pit 13, and as is shown in the figure, from deaeration tank 11 between the end walls of sections 11a₁ and 11a₂ there is a return fitting g for overflow to wire pit 13. Negative pressure pump arrangements in connection with deaeration tank 11 for bringing about a negative pressure in the top section of the deaeration tank are not shown. Air is removed from the fractionated pulp with the
25 aid of a high negative pressure brought about in the deaeration tank by a negative pressure pump.

Such an embodiment is also possible within the scope of the invention, where there is no deaeration of the pulp. In systems with no deaeration of the pulp the
30 accept of the centrifugal cleaning may be taken directly to the suction side of the headbox's feed pump. In other respects the system is similar to the one in the

embodiment shown by Figure 1.

Figure 2A shows one centrifugal cleaner of the first step 12a₁ of a centrifugal cleaner installation. There may be several centrifugal cleaner cones 120 in each step 12a₁, 12a₂ ... The accepts of the cones 120 in each step are combined with each other and the rejects are also combined and then conducted along their respective fittings a₁, b₂; a₂, b₄ ... As is shown schematically in the figure, the heaviest particles move along a helical path downwards in the centrifugal cleaner cone 120 and further out of the cone 120, and from the middle at the top the accepts are conducted forward into the deaeration tank and further into that bypass manifold of the multi-layer headbox, which relates to the concerned fraction. Thus, the fractionation of the centrifugal cleaner is characterised in that fractionation takes place in the said cleaner especially as regards the pulp, whereby the heavier particles move along a helical path to the following step or stage of the centrifugal cleaning, and thus the fractionation takes place also in regard to fillers and additives and not only in regard to fibres.

Figure 2B is a sectional view along line I – I of Figure 2A. Fitting b₁ is joined tangentially to cone 120. The centrifugal force thus separates the heavier particles from the pulp flow L₁ in the space 0 shaped like a truncated cone inside cone 120, while the lighter particles and the pulp fraction separated from the other pulp are conducted (arrow L₂) into deaeration tank 11 of the deaeration equipment by way of fitting a₁.

Figure 3 shows an embodiment of the invention, wherein the tail water is conducted to wire pit 13 along fitting e and the tail water is conducted further from wire pit 13 pumped by pump P₁₀ along fitting b₁ into deaeration tank 11, from which deaeration tank 11 the tail water is conducted further along fitting b₁' pumped by pump P₂₀ to the centrifugal cleaner installation 12. High-consistency pulp, that is, virgin stock, is fed into channel b₁' to the suction side of pump P₂₀. From the first step 12a₁ of the centrifugal cleaner installation 12 the accept is

conducted along fitting a_1 into branch fittings a_1' , a_1'' , which include feed pumps P_1 and P_2 , and the pulp is conducted further through power screens $14a_1$ and $14a_3$ into bypass manifolds J_1' and J_3 of the multi-layer headbox 10. From the first step $12a_1$ of the centrifugal cleaner installation 12 the reject is conducted along fitting b_2 to the second step $12a_2$ of centrifugal cleaner installation 12 as supply, and from the said step the accept is conducted along fitting a_3 pumped by pump P_3 to power screen $14a_2$ and further to the central bypass manifold J_2 of the multi-layer headbox 10 to form the middle layer of the web.

Claims

1. Method for fractionation of pulp in a paper or board machine, whereby in the method virgin stock is conducted to the paper or board machine and further to the first centrifugal cleaner step (12a₁) of a centrifugal cleaner installation (12),
5 **characterised** in that in the method the accept is conducted from the first centrifugal cleaner step (12a₁) into a multi-layer headbox (10) to form a layer of the web determined by the fractionation in question, and that a second fraction or more fractions are conducted from a second step (12a₂) and/or from lower steps
10 (12a₃, 12a₄...12a_n) of the centrifugal cleaner installation (12) into the multi-layer headbox (10) to form a second layer or other layers of the web, which are determined based on the fractionation taking place in the concerned second step or lower steps.
- 15 2. Method according to claim 1, **characterised** in that in the method the accept is conducted from the first step (12a₁) of the centrifugal cleaner installation (12) into the multi-layer headbox (10), which forms the top or bottom layer of a three-layer web, and that the accept is conducted from the second step (12a₂) of the centrifugal cleaner installation (12) into the multi-layer headbox (10), which will form the
20 middle layer of the three-layer web.
3. Method according to claim 1 or 2, **characterised** in that the reject of the first step (12a₁) of the centrifugal cleaner installation (12) is conducted at least partly into a fitting (b₂, b₃) as supply for the second step of the centrifugal cleaner
25 installation (12).
4. Method according to any one of the preceding claims, **characterised** in that in the method a deaeration tank (11) is used, which is formed of several sections, whereby there is a separate supply and discharge fitting (a₁, a₂; a₃, a₄) to the said
30 deaeration tank for each fraction.

5. Method according to claim 1, **characterised** in that the water removed from the wire section is conducted into a wire pit (13), from which the tail water is pumped into the deaeration tank (11) and thence the tail water is conducted forward to the virgin stock mixing point and further into the centrifugal cleaner installation (12).

5

6. Method according to any one of the preceding claims, **characterised** in that in the method the final fractionation result is finished in a power screen (14a₁, 14a₂, 14a₃) fitted in a fitting (a₂', a₂'', a₄) in between the deaeration tank and the multi-layer headbox, and the accept of the power screen is conducted as supply into the
10 bypass manifold (J₁, J₂, J₃) of the concerned layer in the multi-layer headbox, and the reject is conducted back through the wire pit (13) into the centrifugal cleaner installation (12).

7. Equipment for fractionation of pulp in a paper or board machine, **characterised**
15 in that the equipment includes means for feeding virgin stock to the tail water, a centrifugal cleaner installation (12) and a multi-layer headbox (10), whereby there is a fitting (b₁, b₁') for the virgin stock admixed with the tail water to the first step (12a₁) of the centrifugal cleaner installation (12) to conduct the virgin stock admixed with the tail water to the first step (12a₁) of the centrifugal cleaner
20 installation (12) as supply, and that from the first step (12a₁) of the centrifugal cleaner installation (12) there is a fitting (a₁) for the accept of the first step (12a₁) while the concerned pulp fraction is supplied to the multi-layer headbox (10) to form a certain layer of the web, and that the equipment includes at least one other fitting (a₃) from the second step (12a₂) and/or from some lower step/steps (12a₃,
25 12a₄ ...) of the centrifugal cleaner installation (12) to the multi-layer headbox (10) to form a second layer or other layers of the multi-layer web.

8. Equipment according to the preceding claim, **characterised** in that the fitting for accept of the first step of the centrifugal cleaner installation (12) is conducted
30 to the deaeration tank (11), and the fitting (a₂) leading out of the deaeration tank (11), along which fitting the accept of the first step (12a₁) of the centrifugal

cleaner installation (12) is moved, is branched off into branch fittings (a_2' , a_2''), which further join with bypass manifolds (J_1 , J_3) of the multi-layer headbox (10) to form the top and bottom layers of the web.

5 9. Equipment according to claim 7 or 8, **characterised** in that the equipment includes a fitting (a_3) for the accept from the second step (12a₂) of the centrifugal cleaner installation (12) to the deaeration tank (11) and thence further through a fitting (a_4) into the respective bypass manifold (J_2) of the multi-layer headbox (10).

10

10. Equipment according to any one of the preceding claims, **characterised** in that the fitting (a_2' , a_2'' ; a_4) between the deaeration tank (11) and the multi-layer headbox (10) includes a power screen (14a₁, 14a₂, 14a₃), which is used for finishing of the pulp fractionation.

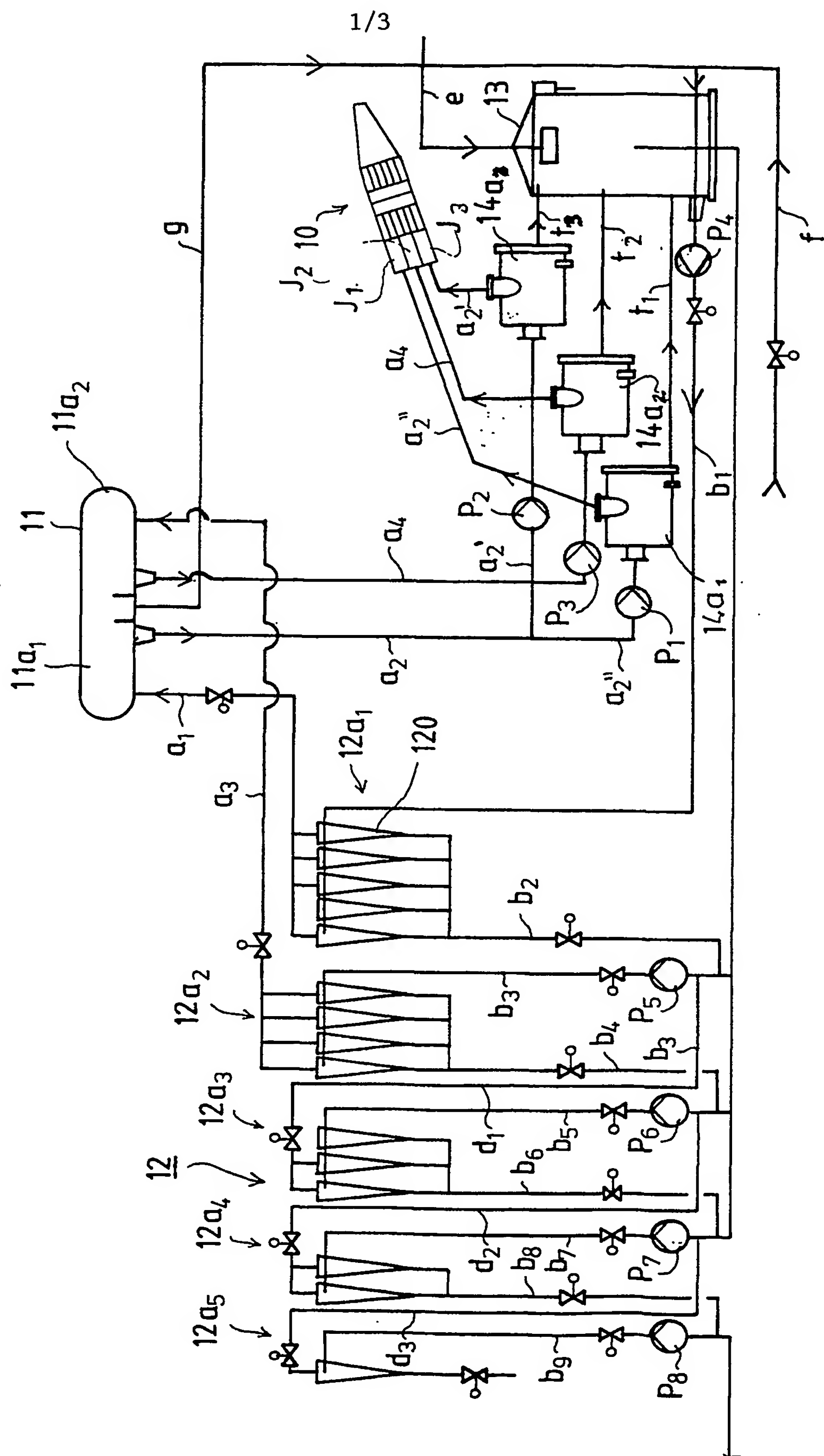
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11. Equipment according to any one of the preceding claims, **characterised** in that from the power screen (14a₁, 14a₂, 14a₃) there is a return fitting (f_1 , f_2 , f_3) for the reject into the wire pit (13).

20 12. Equipment according to any one of claims 7 - 11, **characterised** in that the deaeration tank (11) is in many sections including a section (11a₁, 11a₂) for each pulp fraction and a separate inlet fitting (a_1 , a_3) conducted from the centrifugal cleaner installation (12) into section (11a₁, 11a₂) and a separate outlet fitting (a_2 , a_4) from section (11a₁, 11a₂), and that from the deaeration tank (11) there is a
25 return fitting (g) for overflow back to the wire pit (13).

13. Equipment according to claim 7, **characterised** in that the tail water is conducted from the tail water tank (13) along a fitting (b_1) into the deaeration tank (11), where air is removed from the tail water, and after the deaeration tank (11)
30 the tail water is admixed with virgin stock into a fitting (b_1'), whereupon the pulp is conducted to the centrifugal cleaner installation (12), into its first step (12a₁),

from which there is a fitting (a_1, a_1', a_1'') for the accept to the multi-layer headbox (10) to form a certain layer in the multi-layer web, and that from the first step (12a₁) the reject is conducted into the second step (12a₂) of the centrifugal cleaner installation (12) and that from the second step or lower steps of the centrifugal cleaner installation there is a fitting/fittings for the accept/accepts to the multi-layer headbox (10) to form a second layer or other layers of the multi-layer web.



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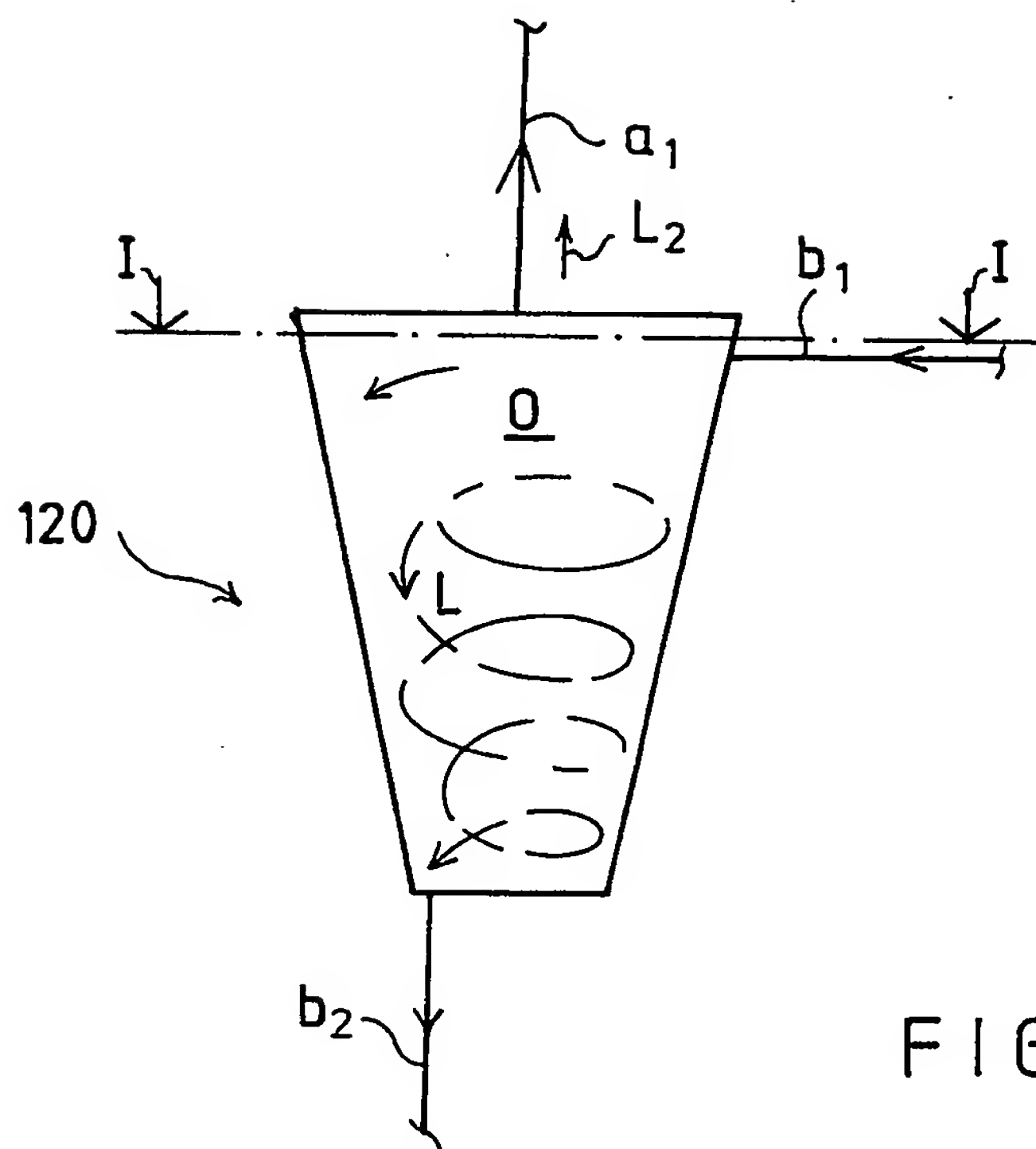


FIG. 2A

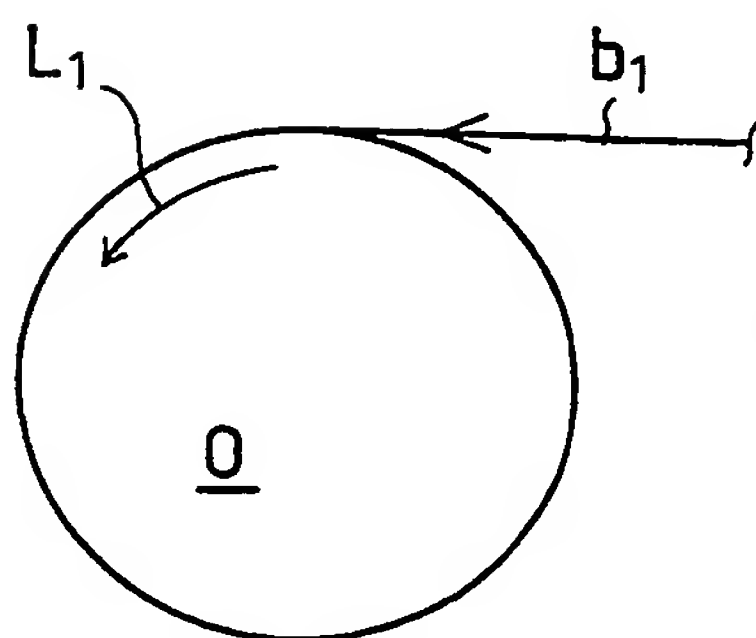
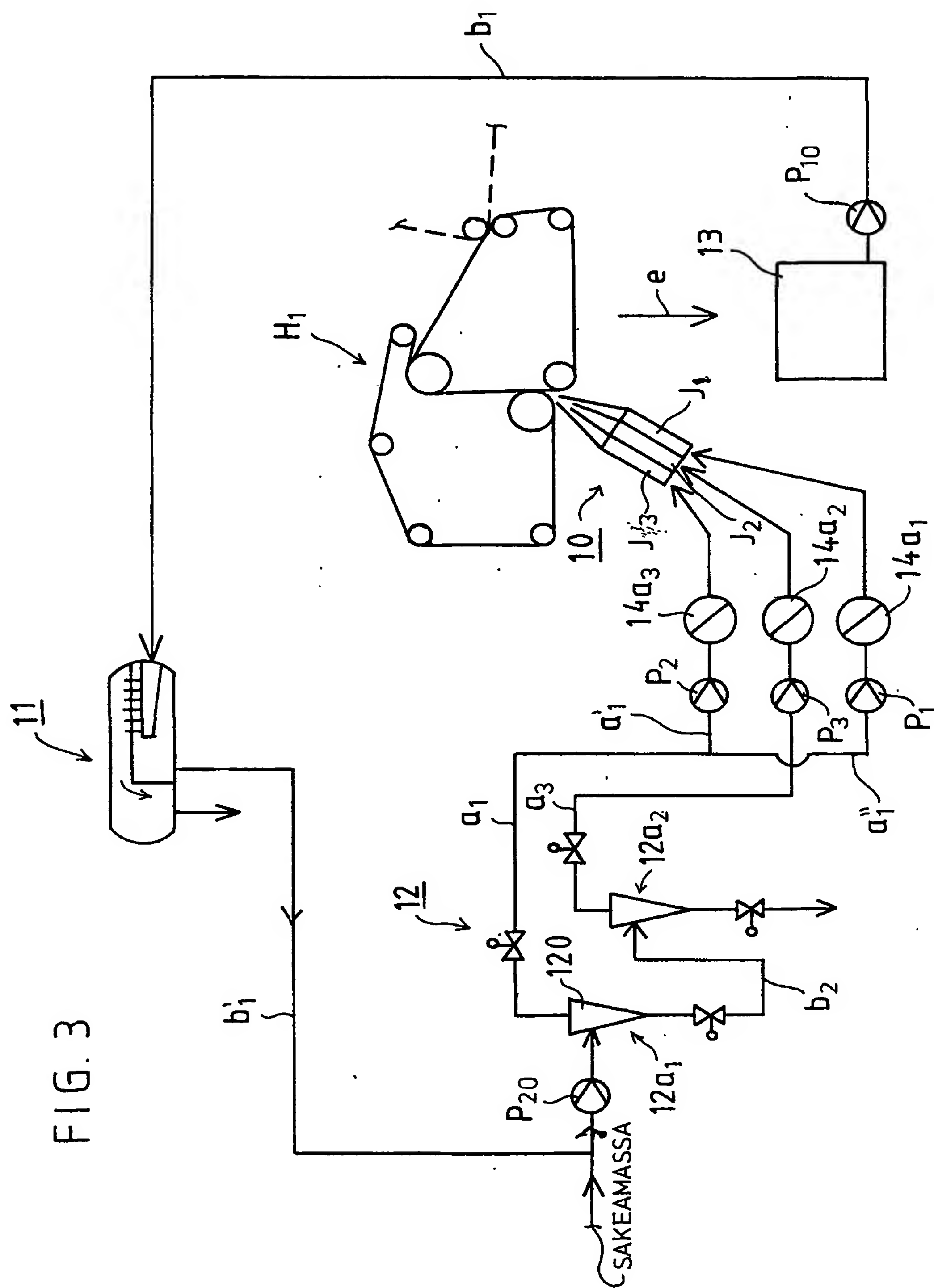


FIG. 2B

FIG. 3



INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 01/00791

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 1/66, D21D 5/24, D21D 5/26, D21F 11/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F, D21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO INTERNAL, WPIDATA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 0129311 A1 (UPM-KYMMENE CORPORATION), 26 April 2001 (26.04.01), figures 1,2, claims 1-10, abstract --	1-13
X	DE 19526205 A1 (VOITH SULZER STOFFAUFBEREITUNG GMBH), 30 January 1997 (30.01.97), column 3, line 29 - line 54, figure 3, abstract --	1-3,6-7, 10-11
Y	--	4-5,8-9, 12-13
Y	EP 1091040 A2 (VOITH PAPER PATENT GMBH), 11 April 2001 (11.04.01), abstract --	4-5,8-9, 12-13

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search 12 December 2001	Date of mailing of the international search report 14 -12- 2001
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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